(3) *Failure Modes resulting from application of Type B telephone line surges.* Registered terminal equipment and registered protective circuitry shall be capable of withstanding the energy of Surge Type B without causing permanent opening or shorting of the interface circuit and without sustaining damage that will affect compliance with these rules.

Rationale for Harmonized Requirement:

The issue of lightning surge simulation was controversial and was considered at length by the TR 41.9 subcommittee. Also, expert opinion was solicited from the TR-41.7 subcommittee (Environmental and Safety Considerations). The final proposal includes two types of surges (Type A and Type B). Each surge type includes metallic and longitudinal surges, and defines allowed failure modes for that type surge.

Type A is essentially the same as the present Part 68 requirements. The existing definition of the current surge waveform is ambiguous. It is the TIA subcommittee's understanding that the original intent of Part 68 was that the current and voltage waveshapes have the same minimum decay time. The current waveshape specification has been added to the surge definition. The text was changed for improved clarity. The longitudinal surges to each lead individually were eliminated. The allowed failure modes are unchanged.

Type B surges are new. The surge waveforms have lower energy, but the acceptance criteria after application of the surges are different. The surge generator for Type B surges are defined in terms of both a voltage waveform and a current waveform. Also, the configuration of the surge generator applies longitudinal surges to each lead through an independent source impedance.

Further, the subcommittees agreed that the best way to specify the surge generator is in terms of open circuit voltage waveform and short circuit current waveform at the output of the generator. This defines the generator in terms of measurable external properties, and also constrains the energy. Measurable external properties include front and decay times. These terms are defined in Figures 68.302(a) and (b) and are consistent with ANSI standards. An idealized circuit diagram for type B surges is given in Figure 68.302(c), but the actual requirements are the voltage and current waveforms.

The following discussion summarizes reasons for proposing the addition of a new surge test and for retaining the existing test.

Surges occur over a wide spectrum of voltages, current and energy. For purposes of evaluating equipment performance, there are Bellcore, ITU-T and TIA standards which can provide guidance. However, in Part 68 the surge is used as a conditioning stress to determine if terminal equipment could harm the network afterwards; it is not a performance standard.

There is a significant body of data which indicates that the energy of the present Part 68 surge is very severe, relative to actual surges that occur. Also, some manufacturers stated that there did not seem to be a correlation between performance with the FCC surge and actual field performance. For example, some products which fail open on the FCC surge (due to blowing a fuse, for instance) have not had problems with failures in the field. Because of these considerations, the surge defined in ITU-T Recommendation K.21 was suggested as a more typical surge waveform and was adopted in this proposal as the Type B surge.

The concern with the existing FCC surge is that the response of the equipment to lower energy surges, which are much more common, is unknown. For Type B surges the proposal is that the equipment must be capable of withstanding the energy of these surges without causing permanent opening or shorting of the interface circuit and without sustaining other damage that will affect compliance. It is not required to be fully operational, but any failures must be non-harmful. These criteria for allowable failure modes ensure that a protection strategy of failing open for high energy surges does not mask other potentially harmful failure modes at lower energies.

It has also been noted that there are a number of equipment failures directly attributed to lightning surges. This has resulted in a number of complaints to the FCC Staff. The committee believes that this proposal to include both surges will address these concerns.

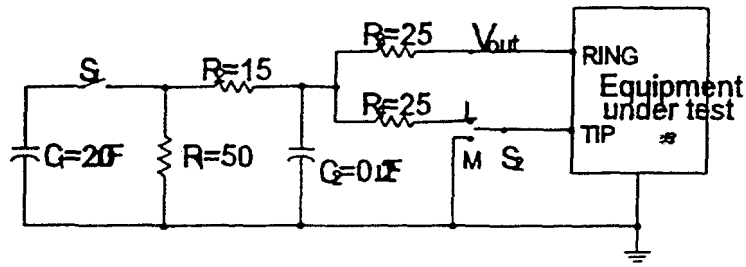
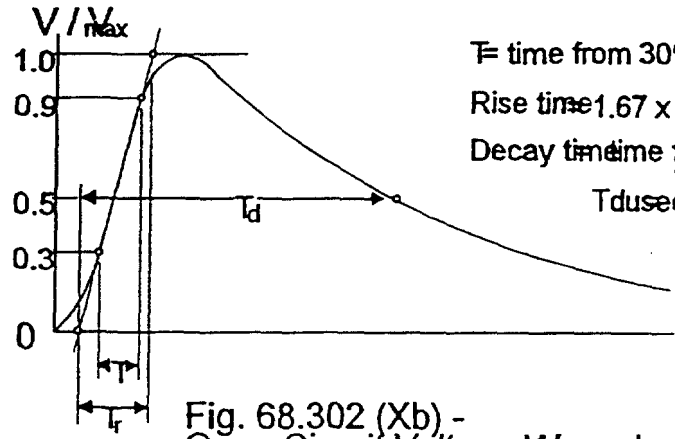


Fig. 68.302 (Xa) - Simplified Surge Generator



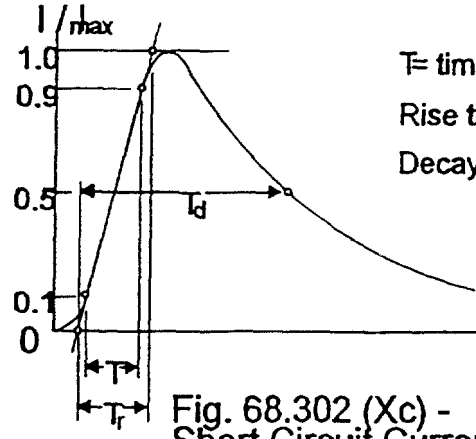
T= time from 30% to 90% of peak vo

Rise time=1.67 x T= us ± 30%

Decay time=time from virtual origin to peak voltage on traili

Tdusec ± 20%

Fig. 68.302 (Xb) -
Open Circuit Voltage Waveshape, Tr x Td



T= time from 10% to 90% of peak current

Rise time=1.25 Tr usec ± 30%

Decay time=time from virtual origin to 50% o peak current on trailing ed

= Td usec ± 20%

Fig. 68.302 (Xc) -
Short Circuit Current Waveshape, Tr x Td

§ 68.302 Environmental simulation.

(Reworded)

(d) *Power Line Surge.*

(1) Apply six power line surges (three of each polarity) between the phase and neutral terminals of the ac power line while the equipment is being powered. The surge shall have an open circuit voltage waveform in accordance with Figure 68.302(a) having a front time (t_f) of 2 μs maximum and a decay time (t_d) of 10 μs minimum and shall have a short circuit current waveshape in accordance with Figure 68.302(b) having a front time (t_f) of 2 μs maximum and a decay time (t_d) of 10 μs minimum. The peak voltage shall be at least 2500 volts and the peak short circuit current shall be at least 1000 amperes. Surges are applied:

(i) With the equipment in states that can effect compliance with the requirements of Part 68. If an equipment state cannot be achieved by normal means of power, it may be achieved artificially by appropriate means.

(ii) With equipment leads not being surged (including telephone connections, auxiliary leads, and terminals for connection to non-registered/non-certified equipment)terminated in a manner which occurs in normal use.

(2) *Failure Modes resulting from application of power line surge.* Registered terminal equipment and registered protective circuitry shall comply with all the criteria contained in the rules and regulations in this subpart, both prior to and after the application of the power line surge specified in section d, not withstanding that this surge may result in partial or total destruction of the equipment under test.

Rationale for Harmonized Requirement:

The existing paragraph 68.302(f) could be interpreted as applying to the power line surge, but this seems to be an ambiguity in the structure of the rules. It is clear that the special failure modes described in existing § 68.302(f) apply only to the telephone connections, and that the failures would occur as a result of surges applied to the telephone connections. These special failure modes are retained for the Telephone Line Surge - Type A.

Based on experience with Part 68 testing, relatively few failures are attributed to Power Line surges. When failures do occur, the typical failure mode is damage to the power supply which renders the equipment partially or totally inoperative. Thus the proposed requirement for this section is a more general statement.

§ 68.304 Leakage current limitations.

(Reworded and Changed)

Registered terminal equipment and registered protective circuitry shall have a voltage applied to the combination of points listed in the table below. The test voltage shall be ac of 50 or 60 Hz rms.

(a) All telephone connections,

(b) All power connections,

(c) All possible combinations of exposed conductive surfaces on the exterior of such equipment or circuitry including grounding connection points, but excluding terminals for connection to other terminal equipment,

(d) All terminals for connection to registered protective circuitry or non-registered equipment,

~~(e) Points having a conducting path to the secondaries of any power supply,~~

(e) All auxiliary lead terminals,

(f) All E&M lead terminals, and

(g) All PR, PC, CY1 and CY2 leads.

Gradually increase the voltage from zero to the values listed in the table below over a 30-second time period, then maintain the voltage for one minute. The current in the mesh formed by the voltage source and these points shall not exceed 10 mA peak at any time during this 90-second interval.

Equipment states necessary for compliance with the requirements of this section which cannot be achieved by normal means of power shall be achieved artificially by appropriate means.

Table 304(a)

VOLTAGE APPLIED FOR VARIOUS COMBINATIONS OF ELECTRICAL CONNECTIONS

Voltage source connected between:	ac Value*
(a) and (b) (see NOTES 1, 2, 3)	1500
(a) and (c) (see NOTES 1, 2)	1000
(a) and (d) (see NOTES 1, 2)	1000
(a) and (e) (see NOTES 1, 2)	1000
(a) and (f) (see NOTES 1, 2)	1000
(a) and (g) (see NOTES 1, 2)	1000
(b) and (c) (see NOTE 3)	1500
(b) and (d) (see NOTE 3)	1500
(b) and (e) (see NOTE 3)	1500
(b) and (f) (see NOTE 3)	1500
(b) and (g) (see NOTE 3)	1500
(c) and (e) (see NOTES 1, 2)	1000
(c) and (f) (see NOTES 1, 2)	1000
(d) and (e) (see NOTE 2)	1000
(d) and (f) (see NOTE 2)	1000
(e) and (f) (see NOTE 2)	1000

*Value to which test voltage is gradually increased.

NOTES:

(1) A telephone connection, auxiliary lead, or E&M lead that has an intentional dc conducting path to earth ground at operational voltages (such as a ground start lead), may be excluded from the leakage current test in that operational state. Leads or connections excluded for this reason shall comply with the requirements of § 68.306(e)(i).

A telephone connection, auxiliary lead, or E&M lead that has an intentional dc conducting path to earth ground for protection purposes at the leakage current test voltage (such as through a surge suppressor), may have the component providing the conducting path removed from the equipment for the leakage current test in that operational state. Components removed for this reason shall comply with the requirements of § 68.306(e)(ii).

Filter paths, such as capacitors used in EMI filters, are left in place during leakage current testing, since these components can be a path for excessive leakage.

(2) For multi-unit equipment interconnected by cables, that is evaluated and registered as an interconnected combination or assembly, the specified 10 mA peak maximum leakage current limitation other than between power connection points and other points, may be increased as described here to accommodate cable capacitance. The leakage current limitation may be increased to (10N+0.13L) mA peak where L is the length of interconnecting cable in the leakage path in meters and N is the number of equipment units which the combination or assembly will place in parallel across a telephone connection.

(3) RF filters and surge protectors on the line side of power supplies may be disconnected before making § 68.304 leakage measurements. As an alternative to disconnecting these filters and surge protectors, this measurement may be made using a dc voltage equal to the peak ac test voltage.

Rationale for Harmonized Requirements:

The 60 Hz value was changed to 50 or 60 Hz to accommodate international frequencies and the UL and CSA use of 50 or 60 Hz in all the related dielectric standards.

Tests between (b) [power leads] and (a), (f), and (g) [telecom leads] are added. The test between power leads and power supply secondaries is deleted. (All references to items are for the proposed text.) However, when the telecom leads are connected to or isolated from the secondary circuits, the added tests are equivalent to the deleted test.

With this change, tests are made between equipment ports only, which is the real concern. No tests are made to inaccessible internal points, so the equipment need not be opened to conduct any leakage current tests.

Note references are added as appropriate. There are three intentional paths to ground considered:

1. Operational paths, such as ground start leads, are excluded from testing (same as present rules). An operational path is identified as having a DC resistance at operating voltages (battery or ringing). The current handling capability of the path is evaluated under Hazardous Voltages.

2. Protective paths, such as MOV's and surge suppressor, are removed before testing. This is the procedure used by UL and CSA for dielectric testing. A protective path is identified as being conductive at leakage current test voltages (1000 V- a surge arrestor fires to protect equipment from such voltages) but being insulative at operational voltages. The insulation properties of the component removed is evaluated at 120 volts under Hazardous Voltages. Typically, a suppressor is rated 130 volts or greater so that it is transparent to ringing voltages.

3. Filter paths are left in place during testing. This is the procedure used by UL and CSA for dielectric testing. The present rules allow these components to be removed and tested at only 120 V. With this proposal it is clear such components must withstand 1000 V during testing, which provides the capability to withstand surges. These paths are identified as not being conductive for DC. To pass a 1000 V test, a capacitor needs about a 400 WVDC rating. These are special capacitors, designated "X capacitors" or "Y capacitors."

Old note 2 has been deleted because of the added clarification to point d.

Old note 4 is not a note to the table, it is a test condition. Therefore, it was moved to the body of the text.

Old note 5 is renumbered and reworded since note 4 was deleted. The proposed changes have eliminated the need to reference Section 68.306.

Old notes 3 and 6 have been deleted because the text has been clarified to specify each test requirement.

§ 68.306 Hazardous voltage limitations.

(Reworded and Delete)

(a) *General.* Under no failure of registered terminal equipment or registered protective circuitry ~~or of equipment connected thereto~~ which can be conceived to occur in the handling, operation or repair of such equipment or circuitry, shall the open circuit voltage on telephone connections exceed 70 volts peak after one second, except for voltages for network control signalling, alerting and supervision~~, which in any case, should be consistent with standards employed by the telephone companies~~.

(1) Registered terminal equipment shall assure that at the MR interface....

Deleted

(2) Registered terminal equipment shall assure that during normal operation at an AIOD interface.....

Deleted

(3) Registered terminal equipment shall also assure that at either an MR channel interface or an AIOD data channel interface....

Deleted

Rationale for Harmonized Requirement

Section (a) has been reworded for clarity.

Sections (1) Message Registration, (2) Automatic Identification of Outward Dialing and (3) MR and AIOD of the existing rules have been deleted.

§ 68.306 Hazardous voltage limitations.

(Reworded and Changed)

(1) *Type I E&M Leads.* Registered terminal equipment shall comply with the following requirements for terminal equipment on the "A" or "B" side of the interface as shown in Figures 68.3(e)(i) & (ii):

(i) The dc current on the E lead shall not exceed 100 mA.

(ii) The maximum dc potentials to ground shall not exceed the following when measured across a resistor of 20 kOhms ± 10 %:

Table 68.306(1)

Type I E&M
DC Potentials

	E Lead	M Lead
TE on "B" side originates signals to network on E lead	± 5 V	±5 V
TE on "A" side originates signals to network on M lead	-56.5 V no positive potential with respect to ground	-56.5 V no positive potential with respect to ground

(iii) The maximum ac potential between E&M leads and ground reference shall not exceed 5V peak.

(iv) M lead protection shall be provided to assure that voltages to ground do not exceed 60 volts. For relay contact implementation, a power dissipation capability of 0.5 watt shall be provided in the shunt path.

(v) If the registered terminal equipment contains an inductive component in the E lead, it must assure that the transient voltage across the contact as a result of a relay contact opening does not exceed the following voltage and duration limitations:

(A) 300 volts peak;

(B) A rate of change of one volt per microsecond; and

(C) A 60 volt level after 20 milliseconds.

(2) *Type II E&M Leads.* Registered terminal equipment shall comply with the following requirements:

(i) For terminal equipment on the "A" side of the interface, the dc current in the E lead shall not exceed 100 mA. The maximum ac potential between the E lead and ground shall not exceed 5 V peak.

(ii) For terminal equipment on the "B" side of the interface, the dc current in the SB lead shall not exceed 100 mA. The maximum ac potential between the SB lead and ground shall not exceed 5 V peak.

(iii) The maximum dc potentials to ground shall not exceed the following when measured across a resistor of 20 kOhms $\pm$ 10 %:

Table 68.306(2)

Type II E&M
DC Potentials

	E lead	M lead	SB lead	SG lead
TE on "B" side of the interface originates signals to network on E lead	±5 V	±5 V	-56.5V; no positive potential with respect to ground	±5 V
TE on "A" side of the interface originates signals to network on M lead	-56.5V; no positive potential with respect to ground	±5 V	±5 V	±5 V

(iv) The maximum ac potential to ground shall not exceed 5V peak on the following leads, from sources in the terminal equipment:

- M, SG and SB leads for terminal equipment on the "A" side of the interface.

- E, SG and M leads for terminal equipment on the "B" side of the interface.

(v) If the registered terminal equipment contains an inductive component in the (E) or (M) lead, it must assure that the transient voltage across the contact as a result of a relay contact opening, does not exceed the following voltage and duration limitations:

(A) 300 volts peak,

(B) A rate of change of one volt per microsecond, and

(C) A 60 volt level after 20 milliseconds.

Rationale for Harmonized Requirements:

These requirements are the same as the current requirements in § 68.306 (a) (4) and (a) (5). 20 kOhms was specified in place of "open circuit." The tables were incorporated in the harmonized requirement for clarity. Steady-state or transient voltages are limited to avoid shock hazards to personnel (60 volts) and damage to equipment (56.5 volts).

The 60 volts value is adopted to be in accordance with international safety requirements.

§ 68.306 Hazardous voltage limitations.

(Reworded)

(3) *Off Premises Station Voltages.*

(i) Talking battery or voltages applied by the PBX (or similar systems) to all classes of OPS interface leads for supervisory purposes must be negative with respect to ground, shall not be more than -56.5 volts dc with respect to ground, and shall not have a significant ac component.*

**The ac component should not exceed 5 volts peak or the dc component shall not exceed 5 volts, where not otherwise controlled by § 68.308.*

(ii) Ringing signals applied by the PBX (or similar systems) to all classes of OPS interface leads shall comply with requirements in paragraph (d) of this section. Ringing voltages shall be applied between the ring conductor and ground.

Rationale for Harmonized Requirement:

This requirement is the same as the current requirement in § 68.306(a)(6). The references to Class A, B, & C OPS has been replaced with "all classes" for clarity.

§ 68.306 Hazardous voltage limitations.

(New)

(4) *Direct Inward Dialing (DID).* Voltages applied by the PBX (or similar systems) to DID interface leads for supervisory purposes must be negative with respect to ground, shall not be more than -56.5 volts dc with respect to ground, and shall not have a significant ac component.*

**The ac component shall not exceed 5 volts peak or the dc component shall not exceed 5 volts, where not otherwise controlled by § 68.308.*

Rationale for Harmonized Requirement:

This requirement has been added for clarity. This was always an implied requirement because DID circuits apply supervisory voltages at the network interface. These voltages must not be hazardous to personnel or interfere with the operation of the network equipment.

§ 68.306 Hazardous voltage limitations.

(Changed)

§ 68.306(5)

(ii) The dc voltage between any conductor and ground does not exceed 60 volts. Under normal operating conditions it shall not be positive with respect to ground (though positive voltages up to 60 volts may be allowed during brief maintenance states);

(iv) Combined ac and dc voltages between any conductor and ground are less than 42.4 volts peak when the absolute value of the dc component is less than 21.2 volts, and less than (32.8 + 0.454 x Vdc) when the absolute value of the dc component is between 21.2 and 60 volts.

Rationale for Harmonized Requirement:

These requirements are the same as the current requirement in § 68.306(a)(7) with the exception of the 60 volts value (the current requirement specifies 80 volts). The formula was also changed to accommodate the 60 volt value.

§ 68.306 Hazardous voltage limitations.

(Changed)

(6) *Ringdown Voiceband Private Line and Voiceband Metallic Channel Interface.* During normal operation, registered terminal equipment for connection to ringdown voiceband private line interfaces or voiceband metallic channel interfaces shall assure that:

(i) Ringing voltage ~~is used for alerting~~ does not exceed the voltage and current limits specified in paragraph (d), and is: (A) applied to the ring conductor with the tip conductor grounded for 2-wire interfaces, or (B) simplexed on the tip and ring conductors with ground simplexed on the tip (1) and ring (1) conductors for 4-wire interfaces.

Rationale for Harmonized Requirement:

This requirement is the same as the current requirement in § 68.306(a)(8). The phrase "is used for alerting only" was considered unduly restrictive and removed. A title was added to this section for clarity.

§ 68.306 Hazardous voltage limitations.

(Changed)

§ 68.306(b)(4)

(ii) Dc voltages less than 60 volts; and

(iii) Combined ac and dc voltages less than 42.4 volts peak when the absolute value of the dc component is less than 21.2 volts and less than (32.8 + 0.454 x V dc) when the absolute value of the dc component is between 21.2 and 60 volts.

Rationale for Harmonized Requirement:

These requirements are the same as the current Part 68 requirement with the exception of the 60 volts value. The formula was also changed to accommodate the 60 volt value.

§ 68.306 Hazardous voltage limitations.

(Reworded)

(d) *Ringing Sources*: Except for class A OPS interfaces, ringing sources shall meet all of the following restrictions:

(1) *Ringing Signal Frequency.* The ringing signal shall use only frequencies whose fundamental component is equal to or below 70 Hz.

(2) *Ringing Signal Voltage.* The ringing voltage shall be less than 300 V peak-to-peak and less than 200 V peak-to-ground across a resistive termination of at least 1 megOhm.

(3) *Ringing Signal Interruption Rate.* The ringing voltage shall be interrupted to create quiet intervals of at least one second (continuous) duration each separated by no more than 5 seconds. During the quiet intervals, the voltage to ground shall not exceed the voltage limits given in § 68.306(a)(3)(i).

(4) *Ringing Signal Sources.* Ringing voltage sources shall comply with the following requirements:

(i) If the ringing current through a 500 Ohm(s) (and greater) resistor does not exceed 100 mA peak-to-peak, neither a ring trip device nor a monitoring voltage are required.

(ii) If the ringing current through a 1500 Ohm (and greater) resistor exceeds 100 mA peak-to-peak, the ringing source shall include a current-sensitive ring trip device in series with the ring lead that will trip ringing as specified in Figure 68.306(a) in accordance with the following conditions:

(A) If the ring trip device operates as specified in Figure 68.306(a) with R = 500 Ohm (and greater) no monitoring voltage is required;

(B) If, however, the ring trip device only operates as specified in Figure 68.306(a) with R = 1500 Ohm (and greater) then the ringing voltage source shall also provide a monitoring voltage between 19 V dc and 56.5 V dc, negative with respect to ground, on the tip or ring conductor.

(iii) If the ringing current through a 500 Ohm (and greater) resistor exceeds 100 mA (peak-to-peak) but does not exceed 100 mA peak-to-peak with 1500

Ohm (and greater) termination, the ringing voltage source shall include either a ring trip device that meets the operating characteristics specified in Figure 68.306(a) with 500 Ohm (and greater), or a monitoring voltage as specified in (4)(ii)(B) above.

NOTE: If the operating characteristics specified in Figure 68.306(a) are not met with both the 500 Ohm and 1500 Ohm terminations, then the terminal equipment under test fails (See Table 68.306(3)).

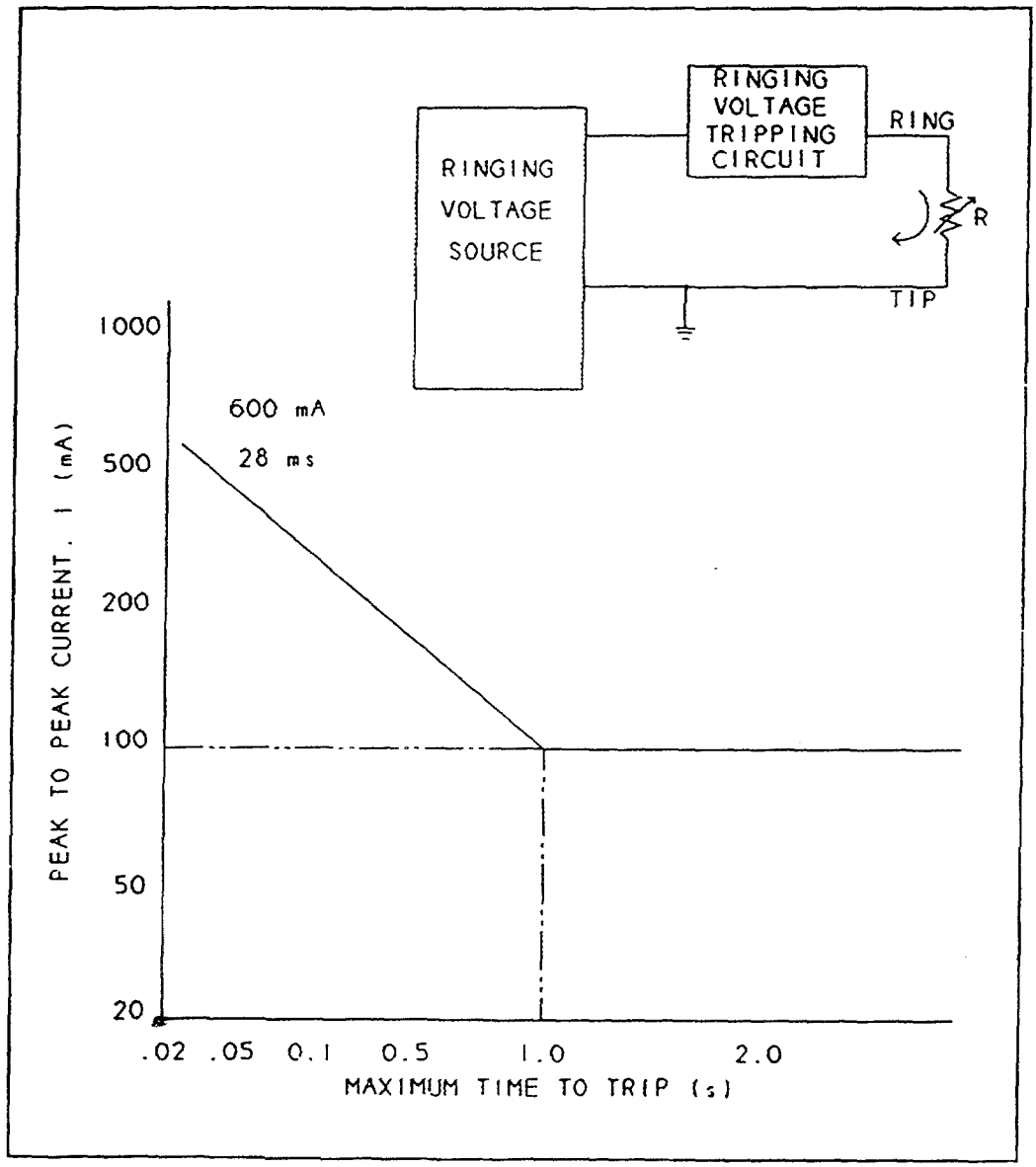


Figure 68.306(a)

Illustration of Ring Trip Requirement

Table 68.306(3)

Summary of Ring Trip Requirements

Section 68.306 (d) (4)	Ringing Current (mA p.p)		Function Required		Ring Trip Device operates per Figure 68.306(a)
	R=500 Ohm & Greater	R=1500 Ohm & Greater	Ring Trip	Monitor Voltage	
(i)	< 100	< 100	Optional	Optional	Optional
(ii) (A)	N/A	> 100	Yes	Optional	Yes for both resistances
(ii) (B)	N/A	> 100	Yes	Yes	Yes for R=1500 Ohm & greater No for R=500 Ohm & greater
(iii)	> 100	< 100	Either Ring-Trip Device or Monitor Voltage required		Yes for R = 500 Ohm & greater, if Ring Trip Device is used

Rationale for Harmonized Requirement:

These requirements are the same as the current Part 68 requirements. The section has been reworded and the additional ring trip table is proposed to clarify the requirements.

§ 68.306 Hazardous voltage limitations.

(Changed)

(e) *Intentional paths to ground* (as required by § 68.304).

(1) *Connections with operational paths to ground.* Registered terminal equipment and registered protective circuitry having an intentional dc conducting path to earth ground at operational voltages that was excluded during the leakage current test of § 68.304 shall have a dc current source applied between the following points:

(i) Telephone connections, including tip, ring, tip 1, ring 1, E&M leads and auxiliary leads, and

(ii) Earth grounding connections.

For each test point, gradually increase the current from zero to 1 ampere, then maintain the current for one minute. The voltage between (i) and (ii) shall not exceed 0.1 volt at any time.

NOTE: In the event there is a component or circuit in the path to ground, the requirement shall be met between the grounded side of the component or circuit and the earth grounding connection.

(2) *Connections with protection paths to ground.* Registered terminal equipment and protective circuitry having an intentional dc conducting path to earth ground for protection purposes at the leakage current test voltage that was removed during the leakage current test of § 68.304 shall, upon its replacement, have a 50 or 60 Hz voltage source applied between the following points:

NOTE: The path to ground is reestablished when the leads are replaced.

(i) Simplexed telephone connections, including tip and ring, tip 1 and ring 1, E&M leads and auxiliary leads, and

(ii) Earth grounding connections.

Gradually increase the voltage from zero to 120 volts rms for registered terminal equipment, or 300 volts rms for protective circuitry, then maintain the voltage for one minute. The current between (i) and (ii) shall not exceed

10 mA peak at any time.

As an alternative to carrying out this test on the complete equipment or device, the test may be carried out separately on components, subassemblies, and simulated circuits, outside the unit, provided that the test results would be representative of the results of testing the complete unit.

Rationale for Harmonized Requirements:

These revised requirements are intended to replace the existing 68.306 (b) (2) & (3) and (c). These tests are potentially hazardous to testing personnel. The revised proposal, along with the proposed changes to the leakage requirements, adequately address the potential network harm.

There are two kinds of intentional connections to ground which are removed or excluded for leakage current testing-

Operational. Ground start lines have a signaling connection to ground that must be capable of carrying enough current for proper signaling. These connections are usually fused for equipment protection. The test here is not for equipment considerations but for the network harm that would result from an open circuit during normal operation.

Protective. Surge arresters like MOV's are intended breakdown paths. To prevent hazard from a ground potential rise (which would put 120 V on tip-ring), a 120 V fault on ground should not break down the surge arrestor. Since the arrestor may be resistive at 120 V, leakage must be specified; 10 mA from all connections is allowed. Tests may be conducted on individual components, in which case the 10 mA applies to the sum of the leakage currents from all devices (which would be equivalent to testing the complete equipment).